A research assistant uses a video camera to record approximately 15 minutes of vehicle activity in order to have a record of the typical vehicle activity, the site conditions, and the duty cycle.

Data collection includes: (1) assessing and recording field conditions; (2) recording vehicle characteristics; (3) operating the PEMS; (4) periodically checking the PEMS to identify and correct (if possible) data collection and quality assurance problems; (5) recording modes of vehicle activity on a separate laptop computer; and, (6) recording video.

Decommissioning includes reversing all of the installation and pre-installation steps, which takes approximately 30 minutes. The PEMS is returned to the laboratory and is cleaned and prepared for the next data collection session. The data from both the PEMS and the separate laptop are saved to multiple copies for storage and backup. The video is archived.

Data Screening and Quality Assurance

Data screening and quality assurance are procedures for reviewing data collected in the field, determining whether any errors exist in the data, correcting such errors where possible, and removing invalid data.

A number of possible errors have been previously identified. However, in the current study, engine data are obtained using a sensor array instead of with an engine scanner. Thus, the data screening and quality assurance procedures required modification.

The procedures include: (a) initial screening based on error flags generated automatically by the Montana system; (b) reviewing and correcting (if necessary) the synchronization of engine, GPS, and exhaust concentration data; (c) identifying and correcting (if possible) problems associated with the sensor array, such as missing or invalid values of MAP, engine RPM, and IAT; (d) identifying problems associated with the gas analyzers, such as large discrepancies between the two gas analyzers, "freezing" of the analyzers (failure to update data), occurrences of zero calibration during which data should not be used, and occurrence of negative values of emissions that are statistically significantly different from zero; and, (e) identifying potential problems with air leakage into the sampling system based on assessment of the air-to-fuel ratio.

For short periods of missing data, such as one or two seconds of missing MAP values, missing values are imputed. For long periods of missing data, the data are flagged as incomplete and are not used for estimating emission rates. If the data have to be resynchronized or if any values have to be corrected, the mass emission rates are recalculated. A 19-step data screening and quality assurance process has been automated using Visual Basic macros in Excel. Details of the procedure and of the macros are available.

Exploratory Analysis of Data

The raw data were analyzed in terms of the effect of engine activity on fuel use and emissions. Rank correlation was used to identify engine variables highly correlated with variations in fuel use and emission rates. Time series plots were used to represent the variation of fuel use and emission rates in terms of different real-world activities. The fuel use and emission rates were found to be highly correlated with the manifold absolute pressure (MAP) of the engine. MAP is a surrogate for engine load.